

BEST AVAILABLE COPY

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



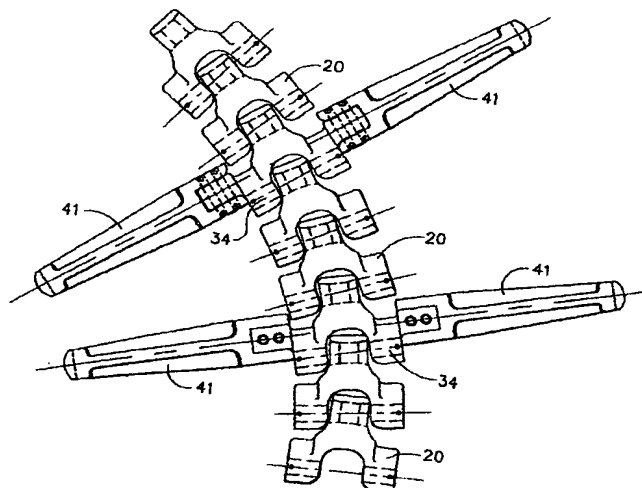
(43) International Publication Date  
11 April 2002 (11.04.2002)

PCT

(10) International Publication Number  
WO 02/28750 A1

- (51) International Patent Classification<sup>7</sup>: B65G 19/08, 19/24, F16G 13/02 (74) Agents: SPRECHER, Kevin, S. et al.; Frost Brown Todd LLC, 2200 PNC Center, 201 East Fifth Street, Cincinnati, OH 45202 (US).
- (21) International Application Number: PCT/US01/31746 (81) Designated States (national): AU, CA, GB, US, ZA.
- (22) International Filing Date: 9 October 2001 (09.10.2001) Published:  
— with international search report
- (25) Filing Language: English
- (26) Publication Language: English For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
- (30) Priority Data: 60/238,877 6 October 2000 (06.10.2000) US
- (71) Applicant and  
(72) Inventor: MORRIS, Randall, Lee [US/US]; 4930 Ginger Way, Cincinnati, OH 45244 (US).

(54) Title: CONVEYOR CHAIN FOR MINING MACHINERY



(57) Abstract: A chain for a conveyor comprising an elongated base means (8, 9) having a bottom and upstanding side guides or flanges (11, 12) is provided. The chain is a continuous chain adapted to be driven so that one of its spans moves longitudinally along the upper surface of the base means bottom (10) and between side guides or flanges in a conveying direction so as to advance the material being conveyed. The chain comprises a plurality of Y-shaped connector links (20) and a plurality of flight arms connecting links (34) having arms attached thereto and normally extending substantially transversely of the conveying direction. Adjacent elements (41) are joined together by a series of bearing and retaining pins (30, 31) so as to permit vertical and horizontal articulation. The flight arms are attached to the flight arm connecting links (34) independently of the main bearing pins (30) that hold the various links of the chain together.

WO 02/28750 A1

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



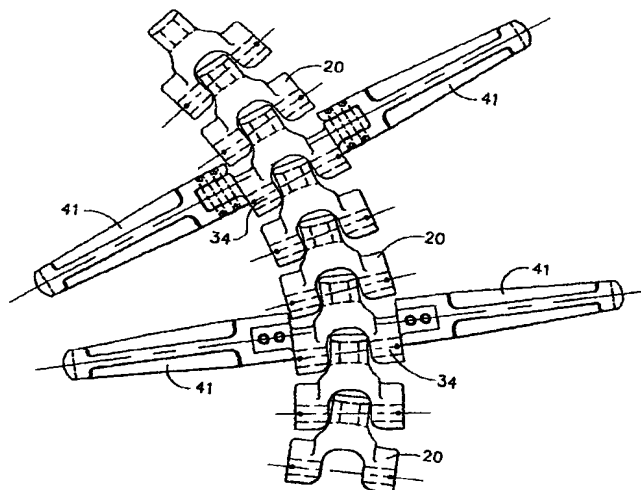
(43) International Publication Date  
11 April 2002 (11.04.2002)

PCT

(10) International Publication Number  
**WO 02/28750 A1**

- (51) International Patent Classification<sup>7</sup>: **B65G 19/08**, 19/24, F16G 13/02
- (74) Agents: **SPRECHER, Kevin, S. et al.**; Frost Brown Todd LLC, 2200 PNC Center, 201 East Fifth Street, Cincinnati, OH 45202 (US).
- (21) International Application Number: PCT/US01/31746
- (22) International Filing Date: 9 October 2001 (09.10.2001)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
60/238,877 6 October 2000 (06.10.2000) US
- (81) Designated States (*national*): AU, CA, GB, US, ZA.
- Published:  
— with international search report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
- (71) Applicant and  
(72) Inventor: **MORRIS, Randall, Lee** [US/US]; 4930 Ginger Way, Cincinnati, OH 45244 (US).

(54) Title: CONVEYOR CHAIN FOR MINING MACHINERY



(57) Abstract: A chain for a conveyor comprising an elongated base means (8, 9) having a bottom and upstanding side guides or flanges (11, 12) is provided. The chain is a continuous chain adapted to be driven so that one of its spans moves longitudinally along the upper surface of the base means bottom (10) and between side guides or flanges in a conveying direction so as to advance the material being conveyed. The chain comprises a plurality of Y-shaped connector links (20) and a plurality of flight arms connecting links (34) having arms attached thereto and normally extending substantially transversely of the conveying direction. Adjacent elements (41) are joined together by a series of bearing and retaining pins (30, 31) so as to permit vertical and horizontal articulation. The flight arms are attached to the flight arm connecting links (34) independently of the main bearing pins (30) that hold the various links of the chain together.

WO 02/28750 A1

## **CONVEYOR CHAIN FOR MINING MACHINERY**

### **Technical Field**

The present invention relates generally to conveyor chains, and, more particularly to mining machinery conveyor chain link bodies with attachments for flight arms.

### **Background of the Invention**

While conveyors with which the chain of the present invention are intended to be used may have many applications, for purposes of an exemplary showing, such conveyors will be described with respect to their use in the mining industry, although their use is not intended to be so limited.

Pusher-type chain conveyors, as used in the mining industry, are found both in the form of separate conveying units, and as integral parts of continuous mining machines. A typical continuous mining machine, for example, is self-propelled and is provided at its forward end with cutting means shiftable in such a way that an entry is cut in the material being mined. The entry is so sized as to permit the passage of the mining machine therethrough. Since the cutting operation is a continuous one, it is necessary to provide means to move the cut material from in front of the mining machine and to convey it out of the entry. To this end, the mining machine usually incorporates one or several conveyors in its construction, the conveyors acting successively to transport the cut material rearwardly of the machine. Frequently, the mining machine further incorporates a "tail conveyor" which is a part of the mining machine, located at its rearward end. The purpose of the tail conveyor is to deliver the cut material to other conveying means by which it is removed from the entry. The other conveying means may comprise mine cars, portable belt conveyors, or the like.

- 2 -

The most frequently encountered form of tail conveyor, in association with a continuous mining machine, comprises a section of conveyor base means mounted on the mining machine body. One or more additional sections of conveyor base means are connected thereto end-to-end, and extend beyond the rearward end of the mining machine body. All of the base means sections are characterized by a bottom portion provided with longitudinally extending, upstanding side guides or flanges. In order for the tail conveyor to perform its task properly, the various sections thereof must be capable of both lateral and vertical movement with respect to each other. This enables the cut material to be delivered to a desired point despite changes of position of the mining machine as it advances in the entry and changes in level of the entry floor. Similarly, this lateral and vertical movement capability of the conveyor sections enables the shifting of the desired delivery point for the material being mined, as required.

The tail conveyor typically incorporates a continuous pusher-type conveyor chain, which is driven along the length of the conveyor base sections. The chain is normally provided with a plurality of rigid pusher elements, normally extending substantially transversely of the conveying direction. The pusher elements are located at spaced intervals along the chain. Adjacent pusher elements are joined together by a series of alternate block-like links and plate-like links. At one end of the machine's conveyor, the continuous chain passes over a driven sprocket. At the other end of the conveyor, the chain passes over a driven or idler sprocket, or roller.

Typically in the underground mining industry, machine downtime is very expensive. Should a conveyor chain fail (due to sudden impact or wear), the chain often would come apart during production causing several hours of expensive and unproductive downtime while the chain was repaired. Most often a conveyor chain fails from impact loads on the flight arms. These impacts over time cause a fracture which then causes the welded-in pins to fail.

- 3 -

**Brief Description of the Drawings**

The accompanying drawings incorporated in and forming a part of the specification illustrates several aspects of the present invention, and together with the description and claims serves to explain the principles of the invention. In the  
5 accompanying drawings:

Figure 1 is a semi-diagrammatic plan view of a typical continuous mining machine having a tail conveyor utilizing a pusher-type conveyor chain;

Figure 2 is a top plan view of one embodiment of the preferred chain connector link of the present invention;

10 Figure 3 is a side elevational view of the connector link of Figure 2;

Figure 4 is a top plan view of one embodiment of the flight arm chain connector link of the present invention;

Figure 5 is a side elevational view of the flight arm chain connector link of Figure 4;

15 Figure 6 is an end view of the flight arm chain connector link of Figure 4;

Figure 7 is a top plan view of another embodiment of the flight arm chain connector link of the present invention;

Figure 8 is a side elevational view of the flight arm chain connector link of Figure 7;

20 Figure 9 is an end view of the flight arm chain connector link of Figure 7;

Figure 10 is a top plan view of one embodiment of the flight arm of the present invention;

Figure 11 is a side elevational view of the flight arm of Figure 10;

Figure 12 is an end view of the flight arm of Figure 10;

- 4 -

Figure 13 is a top plan view of another embodiment of the flight arm of the present invention;

Figure 14 is a side elevational view of the flight arm of Figure 13;

Figure 15 is an end view of the flight arm of Figure 13;

5        Figure 16 is a perspective view of a segment of one embodiment of the improved conveyor chain of the present invention;

Figure 17 is a top plan view of a segment of the improved conveyor chain of the present invention shown in a curved configuration;

10       Figure 18 is a perspective view of a segment of the improved conveyor chain of the present invention using both preferred embodiments of flight arm connector links and flight arms; and

Figure 19 is a side view of the preferred elongated sprocket of the present invention showing a segment of the improved conveyor chain of the present invention being driven thereon.

15

### **Detailed Description of the Invention**

For a better understanding of the invention, reference is first made to FIG. 1, illustrating an exemplary environment for the chains of the present invention. FIG. 1 diagrammatically illustrates a typical continuous mining machine generally indicated at 2 and provided with a tail conveyor, generally indicated at 3. The mining machine has a body portion 4 which is usually mounted on wheels or treads and is self-propelled. At the forward end of the mining machine, cutting means are provided as shown at 5 and 6. These cutting means 5 and 6 may take various well known forms and are mounted on means such as the frame 7, enabling the cutting means to be shifted in such a way that they will cut an entry large enough to receive and to permit advancement of the mining machine 2 in the cutting direction indicated by arrow A.

20

25

- 5 -

By various well known conveying means, the cut material at the forward end of the mining machine is gathered and transported over or through the mining machine to the tail conveyor 3. This last mentioned conveyor comprises a conveyor base means, illustrated in FIG. 1 as made up of two sections 8 and 9. The base means section 8 has a bottom portion 10 and upstanding side guide or flanges 11 and 12. Similarly, the section 9 has a bottom portion 13 and upstanding side guides or flanges 14 and 15. The section 9 is mounted on a boom 16 articulated to the rearward end of the mining machine body 4 as at 17. The articulation is such that the boom 16 and its conveyor base means section 9 are shiftable with respect to the conveyor base means section 8 both in the vertical plane and the horizontal plane for reasons explained above. A pusher-type conveyor chain, generally indicated at 18, extends along the length of the conveyor base means sections 8 and 9 and is adapted to be driven along the upper surface of their bottom portions 10 and 13. It will be understood that the chain 18 is a continuous chain. Normally it will be driven by a sprocket at at least one end of the tail conveyor 3.

As shown in Fig. 1, a typical chain 18 is provided with a plurality of spaced pusher elements 19, extending substantially transversely of the conveying direction indicated by arrow B. It will be seen that the pusher elements preferably extend to both sides of the chain 18 and that the pusher elements are located at predetermined intervals along the length of the chain.

To assure a thorough understanding of the chains of the present invention, the individual parts used to make up the chains will be next described in detail. Reference is first made to FIGS. 2, 3 and 4 in which an exemplary chain connector link of the present invention is generally indicated at 20. In all of the figures, like parts have been given like index numerals.

As best shown in Figures 2 and 3, the improved conveyor chain of the present invention includes a plurality of generally "Y - shaped" chain connector links 20. Each chain connector link 20 preferably includes a pair of spaced forwardly extending arms 21 and a single rearwardly extending arm 22. A space 23 is provided between

- 6 -

each pair of forwardly extending arms 21 that is adapted to receive a rearwardly extending arm 22 of an adjacent chain connector link 20. Preferably, as shown in Figure 2, space 23 is partially defined by a portion 24 of the chain connector link 20 of substantially semi-circular or arcuate cross section. More preferably, each forwardly extending arm 21 includes a chamfered or rounded inner edge 25.

According to an important aspect of the present invention, each rearwardly extending arm 22 includes an elongated hole 26 disposed transversely therethrough. Preferably, as shown in Figures 2 and 3, the elongated hole 26 is preferably of oblong or elliptical cross-section. More preferably, the elongated hole 26 includes a center portion 27 of a lesser diameter than either end portion 28 of the elongated hole.

Each forwardly extending arm 21 includes a transverse opening 29 that is aligned with the transverse opening 29 on the corresponding forward arm 21. Preferably, the transverse openings 29 of the forward arms 21 are substantially of circular cross section. As best shown in Figure 16, and in order to secure a pair of adjacent chain connector links 20 together, a bearing pin 30 is inserted through the transverse openings of the forward arms of one chain link body and through the rearwardly extending arm of another chain link body. The bearing pin is preferably held in place by one or more retaining pins 31 inserted in corresponding retaining pin holes 32 disposed in the forward arms 21 and the bearing pins 30.

As can best be seen in Figure 2, each forwardly extending arm is at least partially of substantially elliptical cross section. Preferably, the distal end of the rearwardly extending arm includes a rounded end 33.

As best shown in Figures 4-6, the improved conveyor chain of the present invention includes a plurality of flight arm connector links 34. Each flight arm connector link 34, similar to each chain connector link 20, preferably includes a pair of spaced forwardly extending arms 21 and a single rearwardly extending arm 22. A space 23 is provided between each pair of forwardly extending arms 21 that is adapted to receive a rearwardly extending arm 22 of an adjacent flight arm chain connector link 34. Preferably, as shown in Figure 4, space 23 is partially defined by a portion 24



- 7 -

of the flight arm chain connector link 34 of substantially semi-circular or arcuate cross section. More preferably, each forwardly extending arm 21 includes a chamfered or rounded inner edge 25.

5 Similar to the elongated holes 26 of the chain connector links 20, each rearwardly extending arm 22 of the flight arm connector links 34 also includes an elongated hole 26 disposed transversely therethrough. Preferably, as described previously, the elongated hole 26 is preferably of oblong or elliptical cross-section. More preferably, the elongated hole 26 includes a center portion 27 of a lesser diameter than either end portion 28 of the elongated hole. Optionally, and as shown  
10 in Figures 4 and 6, the elongated hole 26 may be substantially of circular cross-section.

Preferably, and as described previously, each forwardly extending arm 21 includes a transverse opening 29 that is aligned with the transverse opening 29 on the corresponding forward arm 21. Preferably, the transverse openings 29 of the forward  
15 arms 21 are substantially of circular cross section. As best shown in Figure 16, and in order to secure a flight arm connector link 34 with an adjacent chain connector link 20 together, a bearing pin 30 is inserted through the transverse openings of the forward arms of one chain link body 20 and through the rearwardly extending arm of another chain link body 20 or flight arm connecting link 34. The bearing pin is preferably  
20 held in place by one or more retaining pins 31 inserted in corresponding retaining pin holes 32 disposed in the forward arms 21 and the bearing pins 30.

As best shown in Figures 4 and 5, each flight arm connector link 34 includes a pair of laterally extending flight arm attachment projections 35 adapted to receive a corresponding flight arm. Preferably, each laterally extending flight arm attachment  
25 projection 35 includes at least one, and preferably a pair of, flight arm securing holes 36. Preferably, the each securing hole 36 extends from a front face 37 of the flight arm attachment projection 35 to a rear face 38 thereof. As can be seen in Figure 6, the widths of each flight arm attachment projection 35 is substantially identical to that of adjacent arms 21 and 22.

- 8 -

In an alternate embodiment of the flight arm connecting link 34a, and as best shown in Figures 7-9, the flight arm securing holes are disposed from a top surface 39 of a flight arm attachment projection 35 throughwardly to a bottom surface 40 thereof. In this embodiment, and as shown in Figure 9, the flight arm attachment projections  
5 35 are of a width less than adjacent arms 21 and 22.

Reference is made to Figures 10-12 wherein one embodiment of a flight arm 41 is shown. Preferably each flight arm includes an elongated body 42 having a flat, planar bottom surface 43. The body 42 has a central rib or web 44 acting as a pusher for the material being conveyed. The outer free end of the flight arm 41 is provided  
10 with a knob-like portion 45 which can ride against side guide elements 11, 12, 14 and 15 associated with conveyor sections 8 and 9. A chain link connecting portion 46 is provided with a recess 47 to facilitate attachment to a corresponding flight arm attachment projection 35 of a flight arm connecting link 34. The chain link connecting portion is provided with opposing prongs 48 having bearing holes 49  
15 disposed therethrough. Bearing holes 49 are adapted to match up with corresponding flight arm securing holes 36 of a corresponding flight arm attachment projection 35 of a flight arm connector link 34. Bearing pins may be inserted through holes 36 and 49 to attach components 34 and 41 together. Bearing pins may be held in place by retaining pins disposed through retaining pin holes 51 and 32 of the flight arm 41 and  
20 flight arm connecting link 34 respectively. The embodiment of the flight arm 41 shown in Figures 10-12 is particularly adapted for use with the embodiment of the flight arm connecting link 34 of Figures 10-12.

Various other methods of flight arm attachments to the flight arm attachment link 34 are possible other than the bearing and retaining pin assemblies described. For  
25 example, the flight arm may be doweled, bolted, keyed or interlocked to a corresponding link various ways as known in the art. One advantageous feature of the above described designs of the present invention is the separation of the flight arms from the main bearing pin 30. The separation of the flight arms 41 from the main bearing pins 30, allows for better quality steels to be used without compromising the

- 9 -

main bearing pins 30 toughness and fracture resistance in order to have good weldability (a requirement of prior art designs).

5 It should be appreciated that the various components may be comprised of essentially any suitable material known in the art that exhibits the requisite strength and durability characteristics. The various components are preferably steel and may be forged or are more preferably cast. Preferably the flight arms are comprised of spring steel. In order to reduce noise levels further during operation, composite steel and plastic or urethane components may be used.

10 A similar flight arm embodiment 41A with differently oriented bearing holes 49 and opposing prongs 48 is shown in Figures 13-15. Flight arm 41A is adapted for use with and connection to the embodiment 34A of the flight arm connecting link shown in Figures 7-9.

15 As can be seen in the Figures 16-18, the complete chain will be comprised of both "Y - shaped" chain connector links 20 and flight arm attachment links 34 or 34A with flight attachments 41 or 41A fixedly disposed thereon. Preferably each elongated hole 26 is adapted to "loosely" receive the bearing pin 30 so as to permit articulation and to allow, as a result, the conveyor chain of the present invention to navigate curves (See Figure 17). It should be appreciated that the chain has the ability to negotiate curved conveyor sections by articulating via the elongated hole 26 through which the bearing pin 30 has freedom to "rotate" about the chain center and allow the chain the flexibility it needs to travel through the curved section. This offers a distinct advantage over known prior art chains which incorporate welded-in main bearing pins. The main bearing pin 30 preferably has an interference fit or may have a slight rotating fit in the transverse openings 29 of the forward arms 21 of the chain connector links 20. Depending upon its orientation in use, the links 20, 34, and 34A will preferably ride along the upper surfaces of the bottom portions 10 and 13 of conveyor sections 8 and 9 either on its surfaces 30 and 31 or its surfaces 33 and 34.

20

25

- 10 -

As can be seen in Figure 19, the improved chain of the present invention is preferably driven by a six tooth dual sprocket 52. The chain is preferably designed with an offset in pitch from forward to reverse to allow for the chain to be seated in a corresponding sprocket root 53. Advantageously, this configuration allows for the chain to remain engaged longer on the sprocket and to be conveyed directly onto a loading deck. This configuration serves to minimize interference with loading devices and improves both sprocket and chain life. The dual six tooth sprocket also reduces the chains "striking energy" advantageously reducing chain drive noise.

The foregoing description of a preferred embodiment of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiment was chosen and described in order to best illustrate the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto.

- 11 -

What is claimed is:

1. An improved conveyor chain for a conveyor of the type comprising at least two elongated sections each having a bottom with an upper surface, said conveyor sections being joined together end-to-end such that they can be shifted with respect to each other in lateral horizontal directions and vertical directions upwardly and downwardly, said chain being continuous and being adapted to be driven in a conveying direction along each conveyor section bottom upper surface whereby to advance therealong material to be conveyed, said chain comprising:

- a) a plurality of substantially Y-shaped chain connector links, each of said Y-shaped chain connector links comprising a pair of spaced forwardly extending arms and a single rearwardly extending arm, each of said forwardly extending arms comprising a transverse opening, each of said rearwardly extending arms comprising an elongated hole disposed transversely therethrough;
- b) a plurality of flight arm connector links, each of said flight arm connector links comprising a pair of spaced forwardly extending arms and a single rearwardly extending arm, each of said forwardly extending arms comprising a transverse opening, each of said rearwardly extending arms comprising an elongated hole disposed transversely therethrough, each of said flight arm connector link further comprising of opposing flight arm attachment projections having at least one flight arm securing hole disposed therethrough; and
- c) a plurality of flight arms each adapted to be connected with a corresponding flight arm attachment projection, each of said flight arms comprising an elongated body and an upstanding web

wherein each of said pair of forwardly extending arms of said flight arm connector links and each of said pair of said forwardly extending arms of said Y-shaped connector links are linked with a corresponding rearwardly extending

- 12 -

arm of a corresponding Y-shaped connector link or a flight arm connector link to form an endless chain.

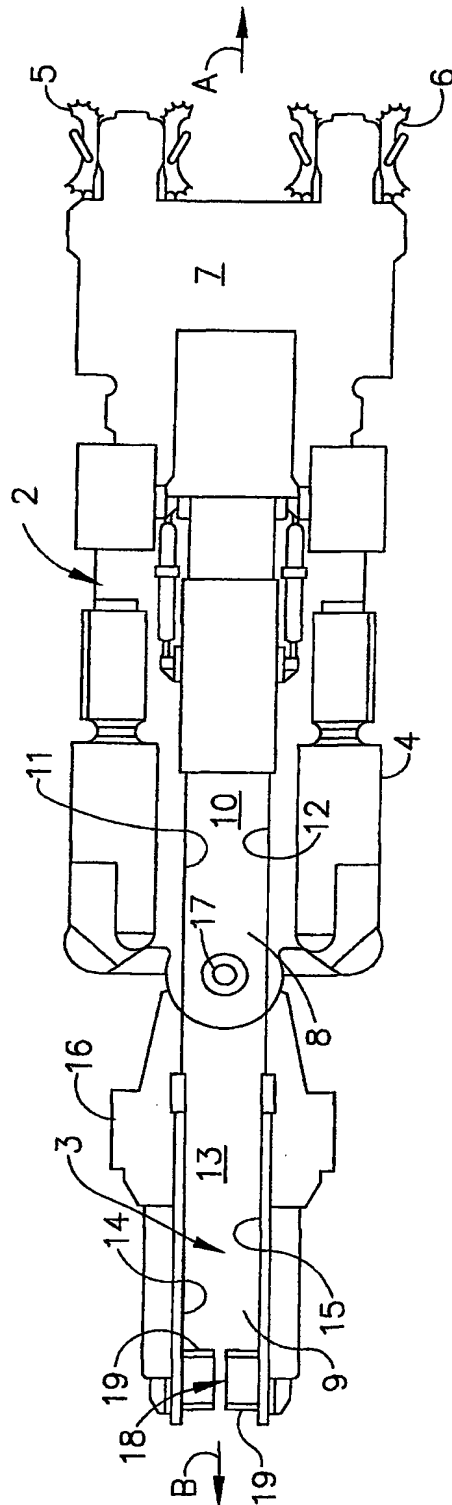


FIG. 1

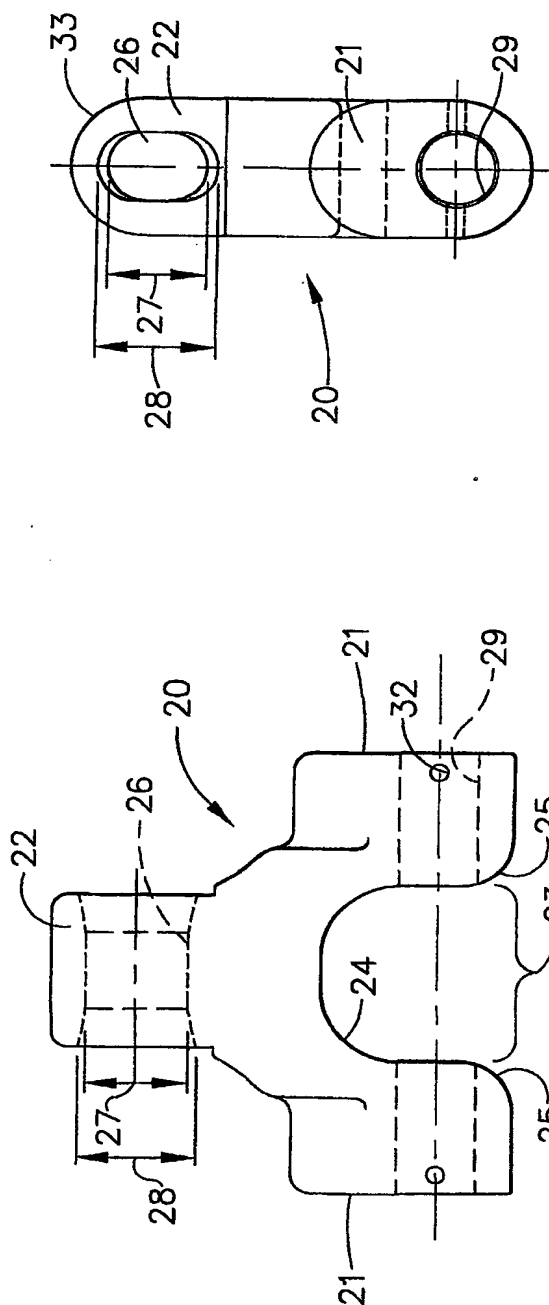


FIG. 3

FIG. 2



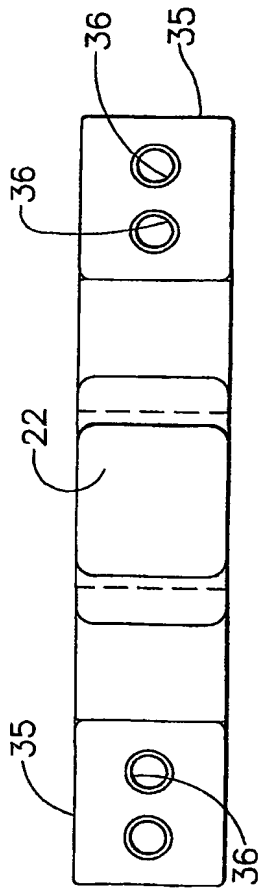


FIG. 5

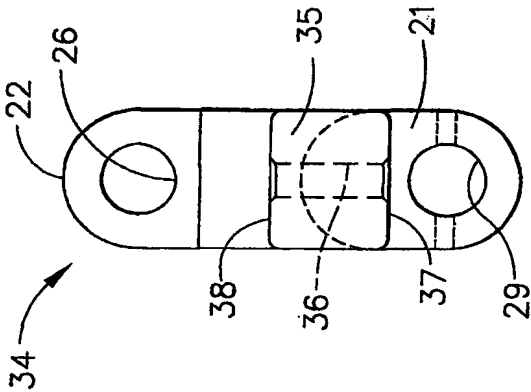


FIG. 6

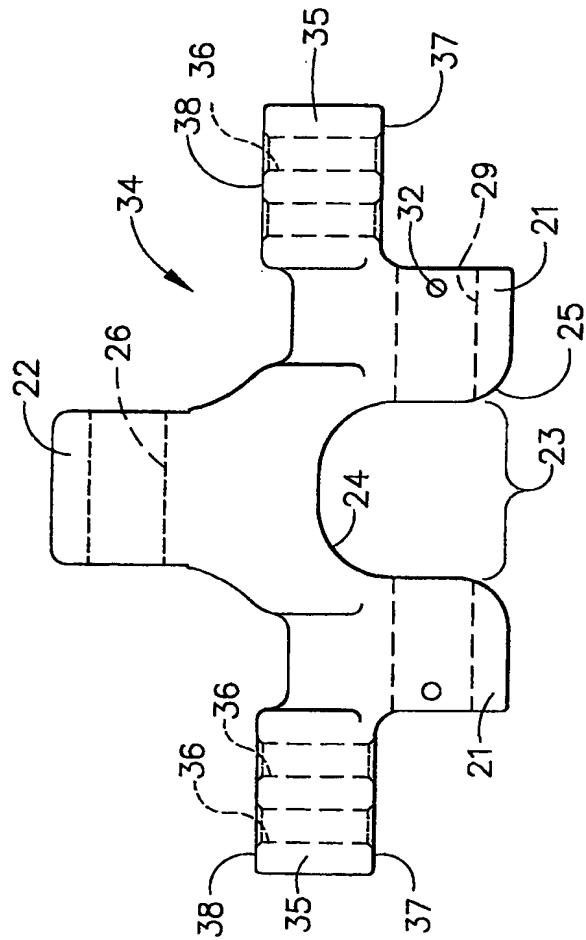


FIG. 4

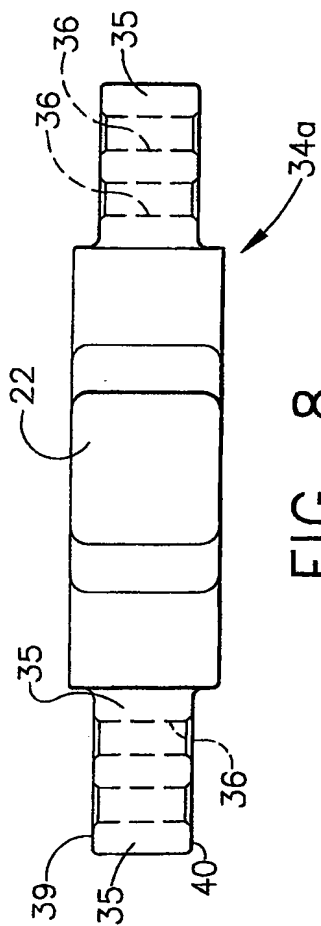


FIG. 8

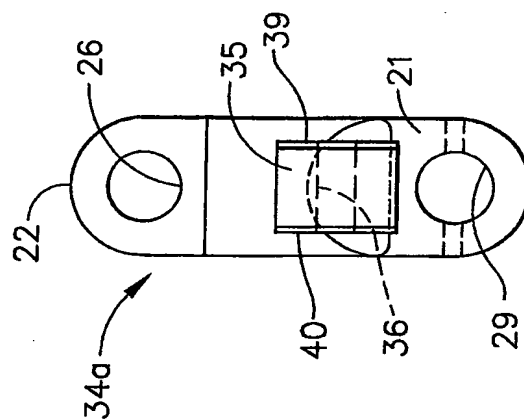


FIG. 9

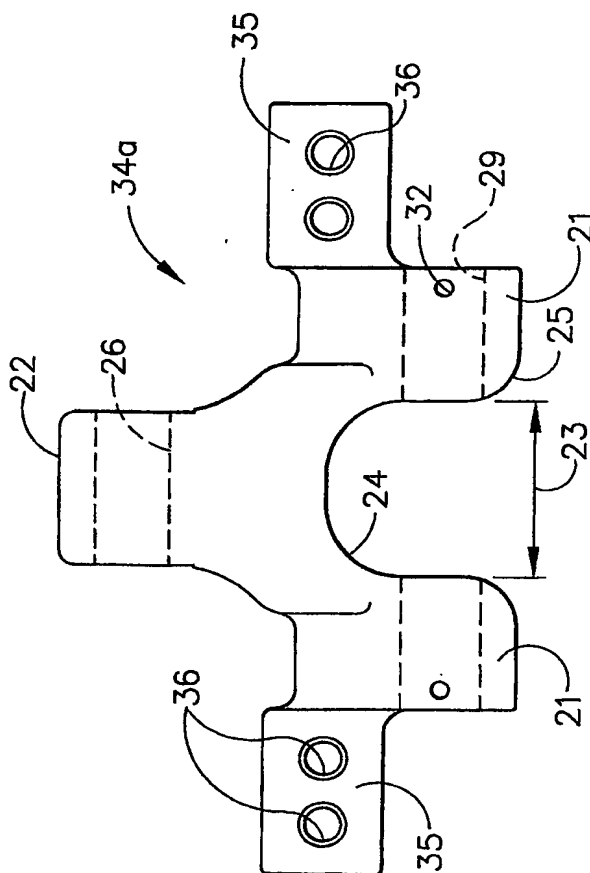


FIG. 7

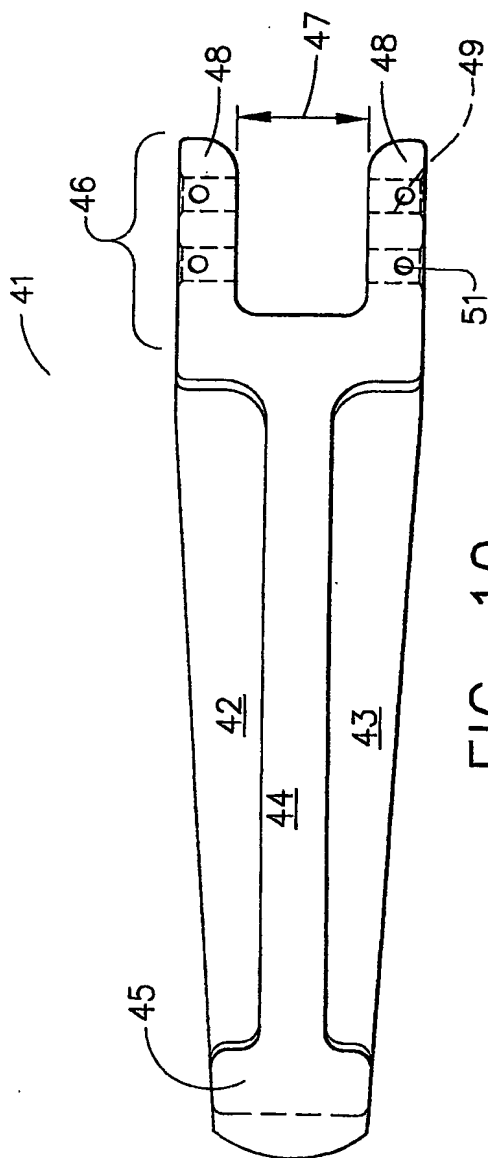


FIG. 10

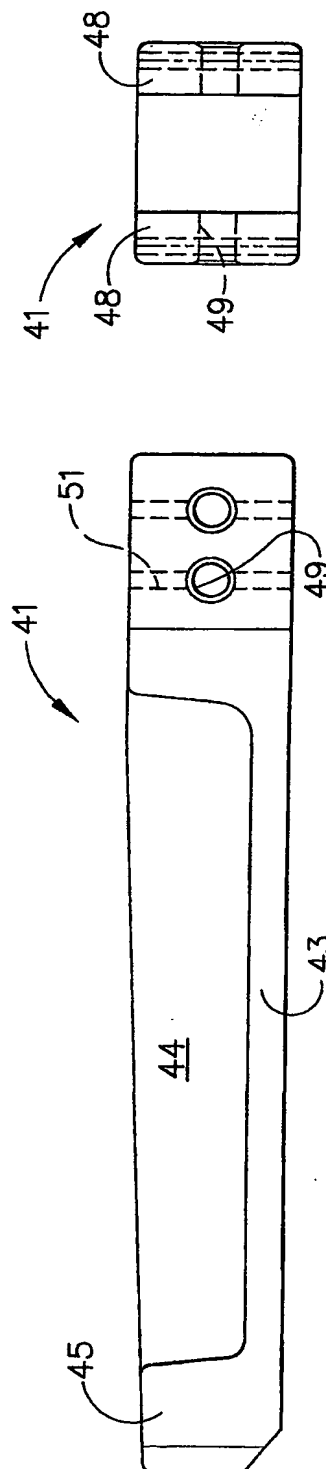


FIG. 11

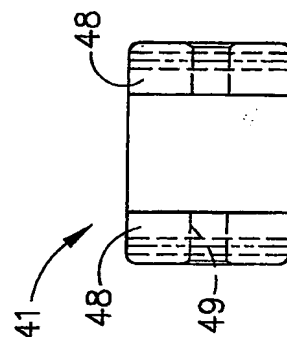


FIG. 12

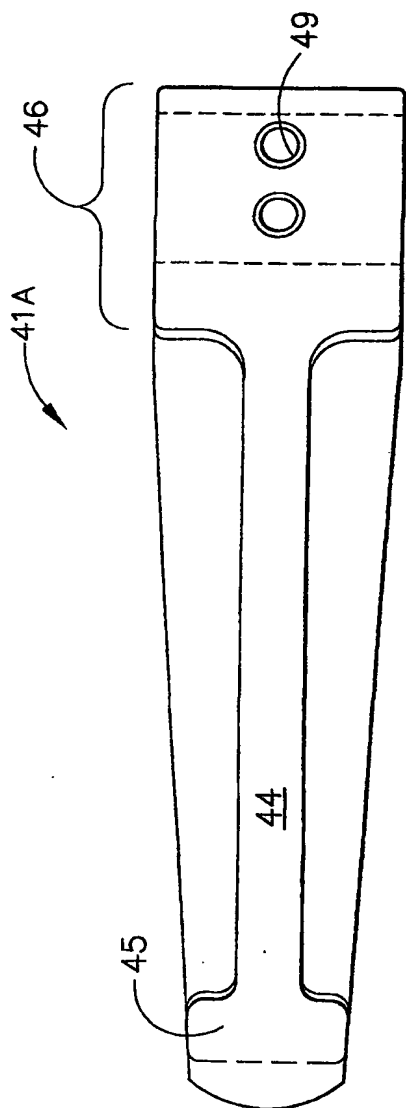


FIG. 13

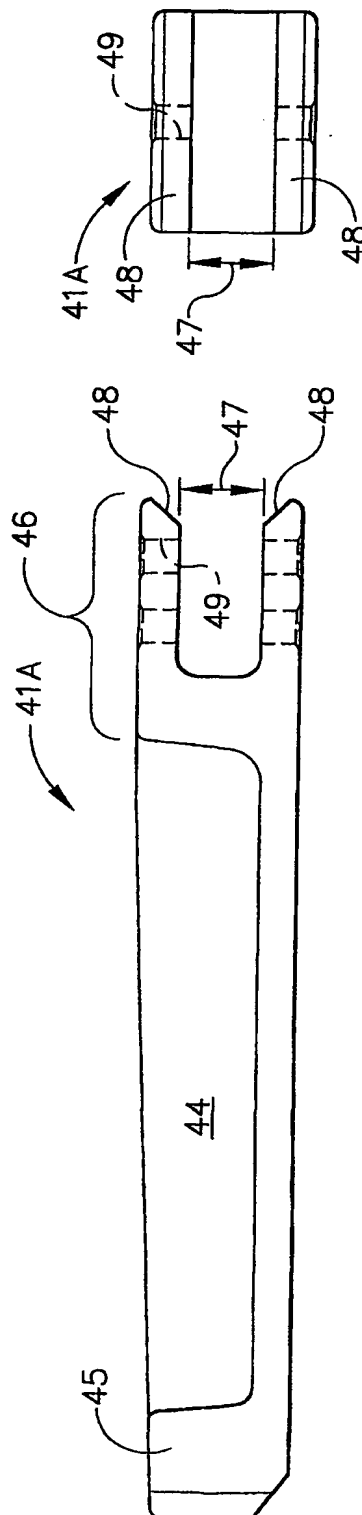


FIG. 14

FIG. 15

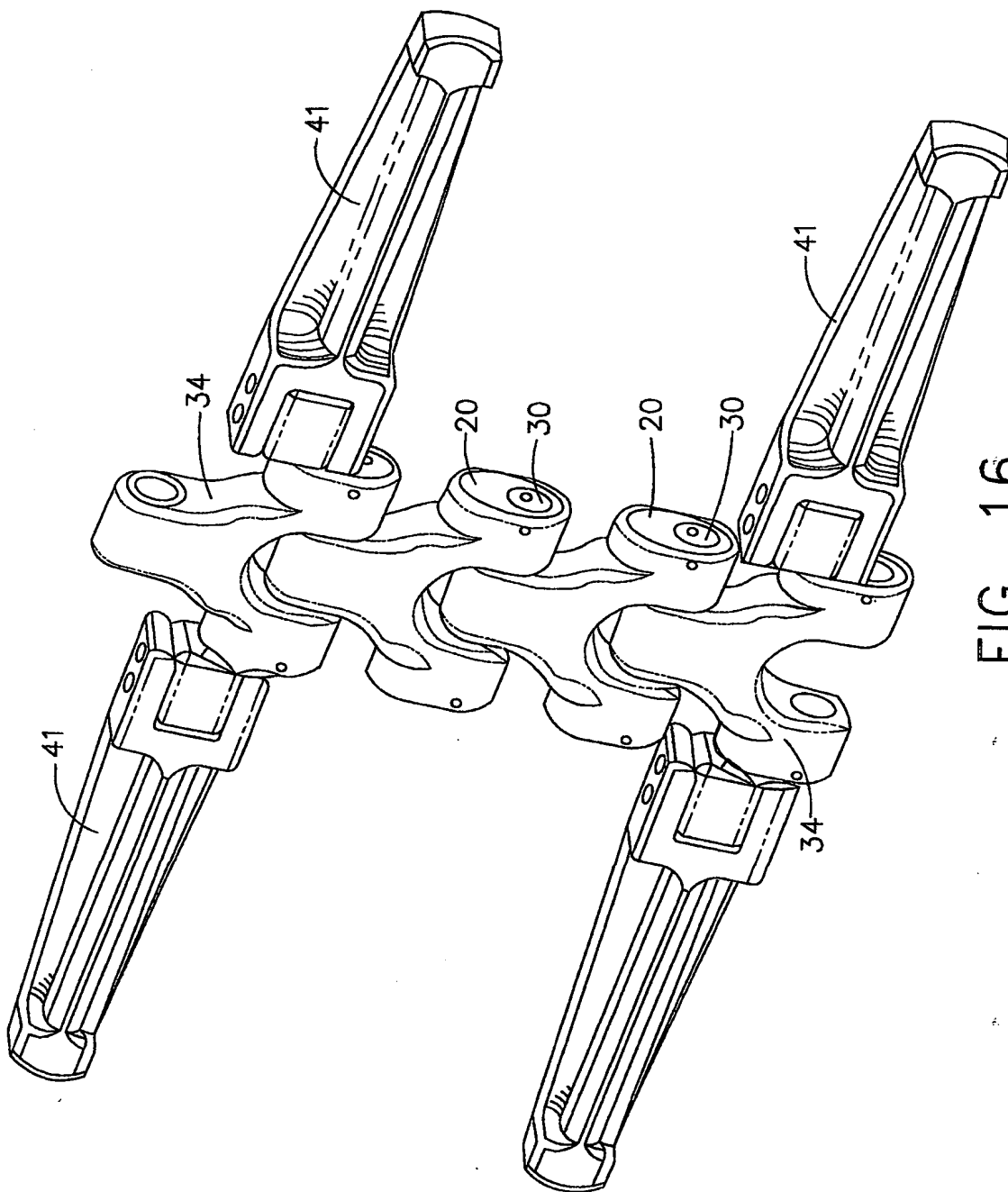


FIG. 16

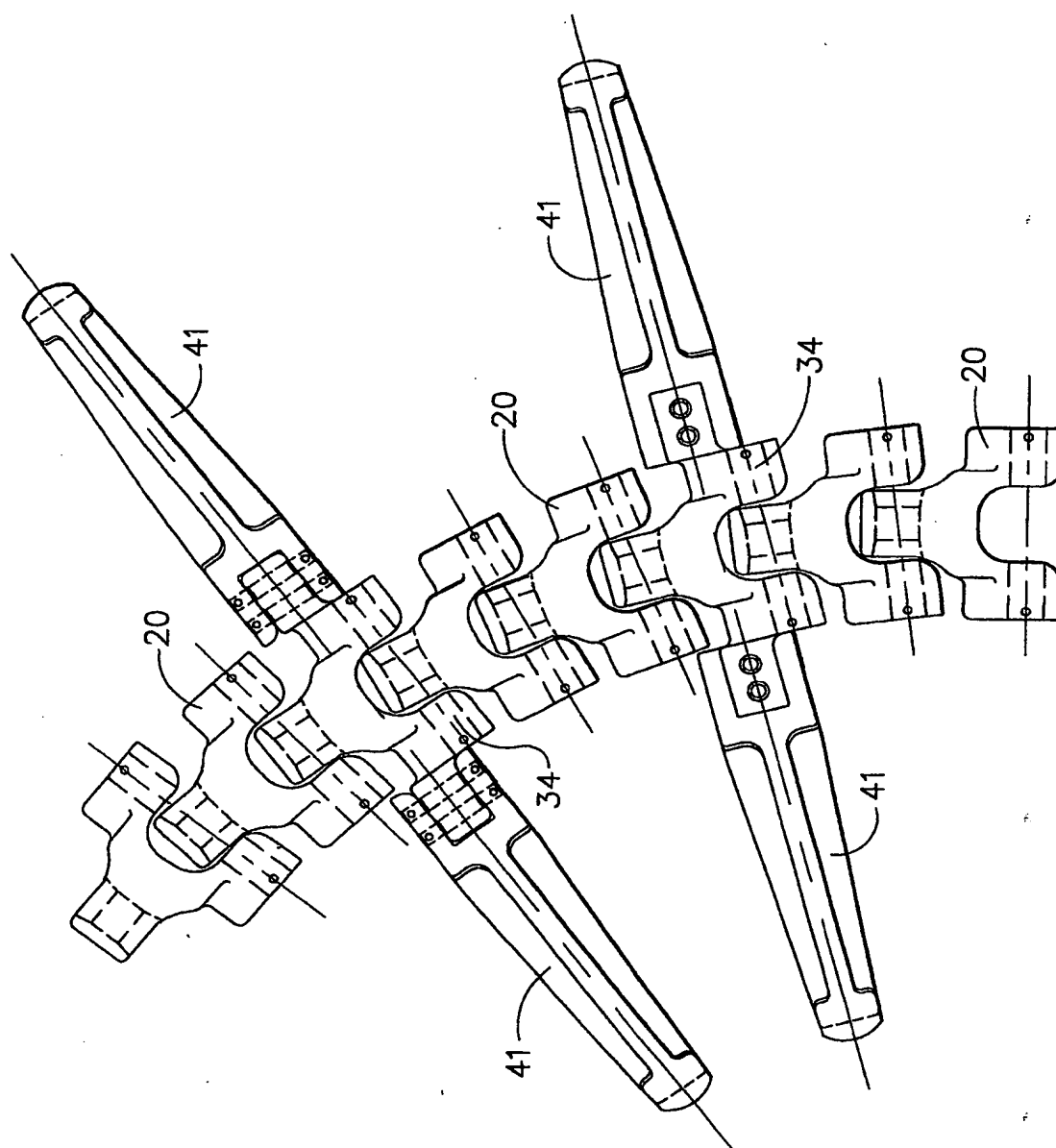


FIG. 17

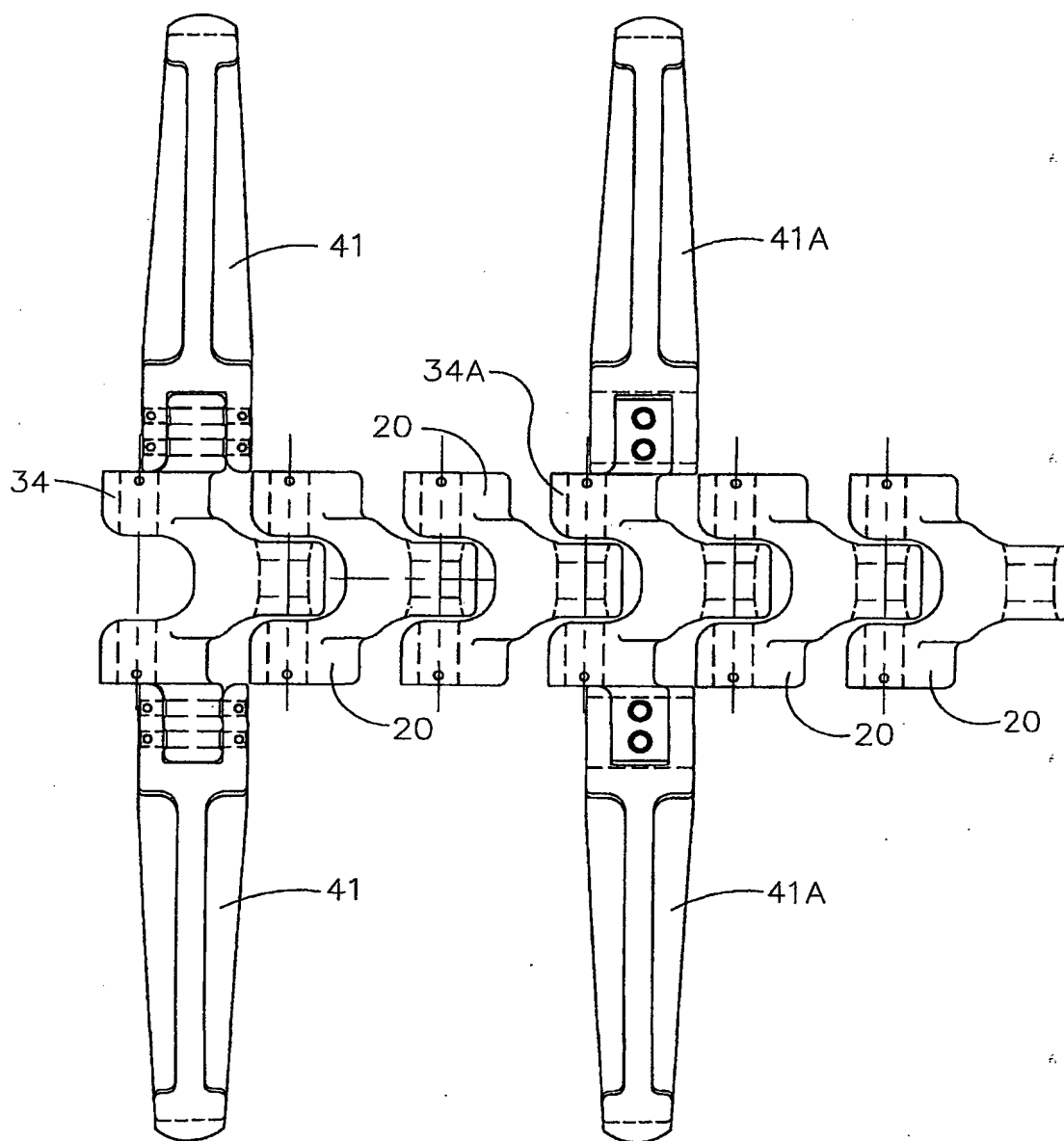


FIG. 18

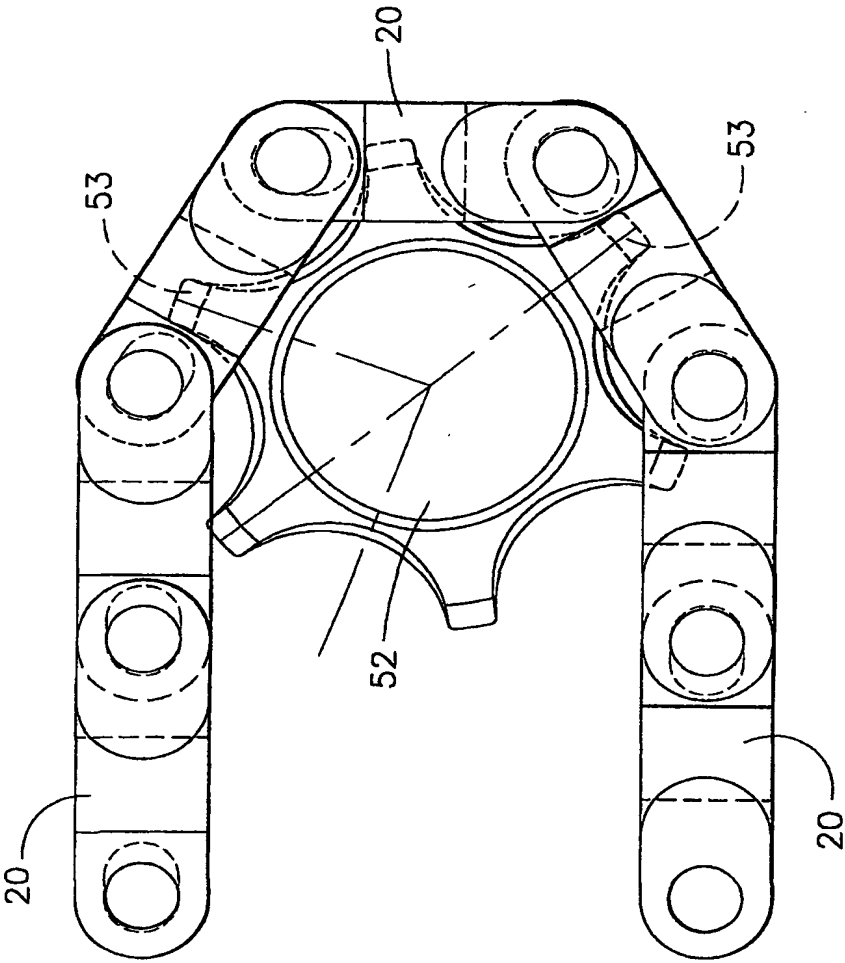


FIG. 19



# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/31746

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B65G 19/08, 19/24; F+ 16G 13/02  
US CL : 198/731, 733; 474/236

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
U.S. : 198/731, 733, 834, 850; 474/236, 226, 155, 210; 59/85

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
East Data base; conveyor and chain and connectors and link and shape and extending

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2,674,365 A (Russell) 06 April 1954 (06-04-1954), see entire document.	1
Y	US 3,641,831 A (Palmaer) 15 February 1972 (15-02-1972), see entire document.	1
Y	US 4,089,406 A (Teske et al.) 16 May 1978 (16-05-1978), see entire document.	1
Y	US 4,766,995 A (Sterwerf, Jr.) 30 August 1988 (30-08-1988), see entire document.	1
A	US 2,756,869 A (Merck et al.) 31 July 1956 (31-07-1956), see entire document.	1
A	US 3,324,990 A (Karlovsy, Jr) 13 June 1967 (13-06-1967), see entire document.	1

☒ Further documents are listed in the continuation of Box C.



See patent family annex.

### \* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance  
"E" earlier application or patent published on or after the international filing date  
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)  
"O" document referring to an oral disclosure, use, exhibition or other means  
"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

18 December 2001 (18.12.2001)

Date of mailing of the international search report

11 JAN 2002

Name and mailing address of the ISA/US

Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

David Bucci *Diane Smith for*  
Telephone No. (703) 308-2168

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☒ ~~FADED TEXT OR DRAWING~~
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☒ ~~LINES OR MARKS ON ORIGINAL DOCUMENT~~
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**